Siemens' machines have given the greatest amount of efficiency. For subdividing the light, the Jablochkoff system, certainly, has had the greatest success; but the new Siemens machine should be capable of doing quite as much work. At present the Siemens and the Gramme appear to be ahead of any other system, and have, therefore, been adopted most extensively.

I have not in this paper attempted to enter into any details with respect to the economy of any system, or its relative value as compared with ordinary means of illumination.

The results of experiments I shall shortly be engaged in will, I hope, enable me to lay before you some information on this part of the subject.

Art. IX.—*An Improved Ombrograph, or Self-registering Rain-Gauge.*

By R. L. J. Ellery, F.R.S., F.R.A.S.

[Read September 9th, 1880.]

On the 16th May, 1878, I gave a description of a new self-registering rain-gauge that I had devised, which appears at page 2 of Vol. XV. of our *Transactions*, accompanied by a rough diagram of the arrangement. This apparatus has been in use at the Observatory ever since, and, with the exception of an occasional failure of the intermittent syphon by which it empties itself immediately a quarter of an inch of rain has fallen, it has always worked very satisfactorily. It, however, became apparent to me that it was open to considerable improvement in one or two particulars, which I think I have now succeeded in accomplishing. It will be remembered that the instrument referred to consisted of a receiving vase suspended by two well-made steel spiral springs about five inches long and three-quarters of an inch in diameter. Into this vase the rain as collected in the rain-gauge flowed, the springs stretching as the vase descended with the increasing weight of the collected water

until a quarter of an inch of rain had fallen, when an intermittent syphon within the vase overflowed with the last drop or two of the arranged amount, emptying the vase in a few seconds, which gradually rose to its zero position. In descending, the vase raised a light pen frame, carried between vertical guide wires; a glass pen, charged with aniline and glycerine ink, being suspended like a pendulum in the frame, marked on paper stretched on a cylinder revolving on a vertical axis once in 24 hours every movement of the vase, thus furnishing a graphic record of the time, intensity, and duration of rainfall in a very reliable and satisfactory manner.

One point which appeared open to improvement was the mode of communicating to the pen the movements of the vase, which was done by a fine platinum wire passing upwards from the top of the vase over two delicate pulleys downwards to the pen frame; both pulleys and wire guides produced sufficient friction to interfere somewhat with the ultimate accuracy of the quantity register. The other direction in which improvement was required was indicated by the fact that the syphon took a very sensible interval to empty the vase—say from fifteen to twenty seconds—and that in this interval in heavy rains an appreciable amount of rain might flow into the vase which would overflow with the rest without giving any indication on the register that more than a quarter of an inch had fallen. This defect, of course, would not be very appreciable except in heavy rains; still it is in heavy rains that the most accurate measures of intensity of fall are required, and, therefore, a practical method of meeting this difficulty was wanted.

The new instrument—*ombrograph*, as it may be styled—is on the table at work, and you can see the action, and also how the defects I have referred to have been met. In the first place, the pen is suspended from a little gallows on the vase itself, any movement of which is recorded directly on the cylinder without intervention of pulleys; to prevent the swinging to which a weight hung by spiral springs is very liable to, the vase has two vertical ribs of thin metal, which run loosely in two grooved guide wheels, running on fine steel axles, by which contrivance a steady vertical movement downwards and upwards of the vase, and therefore of the pen, is secured.

In the second place, a simple little intermediate tubular receiver has been added, into which the water from the

rain-gauge collector flows on its way to the vase. In this receiver is a valve, which is ordinarily kept open by a small counterpoised lever on the top of the tube, allowing the rain to trickle unobstructed into the vase ; immediately, however, the syphon commences to act, and it delivers the first drop at the longer leg, the falling water depresses a small bucket on the end of a lever, which pulls down the valve lever, to which it is connected by a very light wire, and the valve at once closes the tubular reservoir, allowing no more than exactly the quarter of an inch to enter the vase until it is quite empty, for as the last drop flows out the counterpoised lever lifts both bucket and valve, and the small amount accumulated while the syphon was acting is delivered into the vase just as it comes back to zero. This syphon empties the vase in nine seconds, and it must be evident with this arrangement that the register will be as accurate as can well be desired, and, I think, quite as accurate as necessary.

There are two parts of this instrument I should like to say a few words upon—the *spiral springs* and the *hanging pen.* I find that Dr. Draper, of the New York Meteorological Observatory, speaks most highly of the performance of carefully made spiral springs of steel wire, for many purposes of measurement in meteorology, and my own experience entirely coincides with his. Spiral springs made of piano wire, carefully wound on a turned and hollow iron mandril, evenly hardened, and tempered at the temperature of burning oil *before removing from the mandril,* appear to be perfectly resilient, and some I have had in use for nearly three years give the same results in weighing as when first made. For delicate measures, of course, the spirals must be long; the longer they are the more difficult it is to harden and temper them properly, and it becomes necessary to heat them for both processes inside of an iron tube, which can be evenly heated throughout. I am about to attempt making such spirals 18 inches long. The other matter I wish to draw your attention to is the form of pen. It is simply a piece of small glass tube, drawn down at one end to a point with a fine capillary bore, and is very easily made. This pen is fixed in a little wire holder, which hangs on the gallows or frame like a small pendulum, with the pen as its bob, and free to move backwards and forwards in a vertical plane passing nearly through the axis of the barrel. Its point is so adjusted that it rests against the paper with a minimum of pressure and, therefore, with the smallest amount